AD_____

Award Number: W81XWH-11-1-0831

TITLE: Application of Near Infrared Spectroscopy, Intravascular Ultrasound and the Coronary Calcium Score to Predict Adverse Coronary Events

PRINCIPAL INVESTIGATOR: Dr. Charles Lambert

CONTRACTING ORGANIZATION: University Community Hospital – Now Florida Hospital Tampa (Post Merger)
Tampa, Florida 33613

REPORT DATE: October 2013

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| October 2013 | Annual | 26September2012-25September2013 |

**4. TITLE AND SUBTITLE**
Application of Near Infrared Spectroscopy, Intravascular Ultrasound and the Coronary Calcium Score to Predict Adverse Coronary Events

**5a. CONTRACT NUMBER**
W81XWH-11-1-0831

**6. AUTHOR(S)**
Dr. Charles Lambert

**5b. GRANT NUMBER**
W81XWH-11-1-0831

**5c. PROGRAM ELEMENT NUMBER**

**5d. PROJECT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
**AND ADDRESS(ES)**
**University Community Hospital (Now Florida Hospital Tampa)**
**3100 East Fletcher Ave**
**Tampa, Florida 33613**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

U.S. Army Medical Research and Materiel Command

**Fort Detrick, Maryland 21702-5012**

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**10. SPONSOR/MONITOR'S ACRONYM(S)**

**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

**12. DISTRIBUTION / AVAILABILITY STATEMENT**
Approved for Public Release; Distribution Unlimited

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**
Continued review and revision of the initial protocol resulted and IRB approval effective July 15, 2013.
Subsequently, staff and investigator training for the new year infrared System was accomplished.
An initial cohort of sixteen patients were studied as targeted in our quarterly report milestone dated July 17 2013. This data set is included in this report.
Successful infrared spectroscopy and intravascular ultrasound measurements were obtained on all run-in patients.
Feedback to development engineers has resulted in console and electronic redesign, Improvements and pullback functionality, and importantly, improvement in catheter design with respect to profile and image quality. This has resulted in A recent upgrade to the operational system in our laboratory. This system with associated catheters will be used in studies beginning in November 2013.

**15. SUBJECT TERMS**
coronary artery disease, near infrared spectroscopy, calcium scoring, intravascular ultrasound

**16. SECURITY CLASSIFICATION OF:**

| a. REPORT<br>U | | | | | |
|---|---|---|---|---|---|
| | | | 17. LIMITATION OF ABSTRACT<br>UU | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON<br>USAMRMC |
| | | | | | 19b. TELEPHONE NUMBER *(include area code)* |

## Table of Contents


| | Page |
|---|---|
| **Introduction** | **5** |
| **Body** | **6** |
| **Key Research Accomplishments** | **11** |
| **Reportable Outcomes** | **11** |
| **Conclusion** | **11** |
| **References** | **12** |
| **Appendices** | **12** |

## Introduction

The aim of the present project is to

1. Utilize near infrared intra-coronary spectroscopy as an adjunctive technique during cardiac catheterization to identify potential vulnerable plaque morphology
2. Relate its presence to intermediate and long-term outcomes in patients defined as angina, myocardial infarction, death, congestive heart failure, stroke and need for revascularization over five years.
3. To compare near infrared intra-coronary spectroscopy data to that from coronary calcium scoring, angiographic findings and intracoronary ultrasound in predicting those outcomes in #2.

## Body

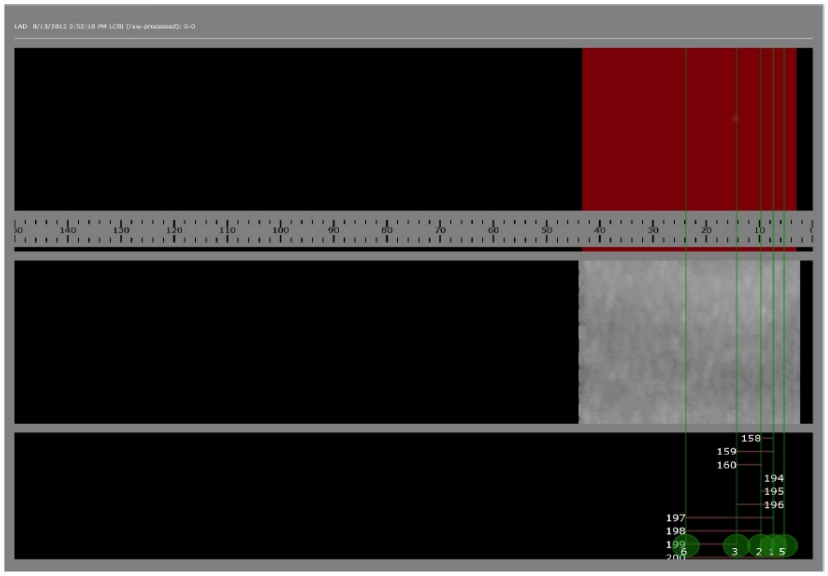
Revision and review of the original protocol was followed by institutional review board approval of the protocol with final informed consent revision effective on July 15 2013.

Staff and physician training was subsequently accomplished. As indicated in the quarterly report dated July 17, 2013, an initial cohort of run-in patients was to be studied with the intravascular ultrasound and infrared spectroscopy components. This was to gain experience with the system and to analyze the data collected during the study with respect to quality and reliability.

Representative data for several patients included in the initial experience with the system are included below. A longitudinal scan of the left anterior descending coronary artery for patient 007 is presented below. The horizontal axis represents full potential excursion of the catheter system. In this particular case only a portion of this excursion was utilized. This is represented by the red and gray portions of the scan. This patient had no discernible coronary artery disease and no discernible lipid plaque. Location of the catheter tip where the sensors are located at index points is illustrated by green lines and the corresponding location identifiers.

JEM - 020-007_1 - 001_1 - LAD

NIR Information:

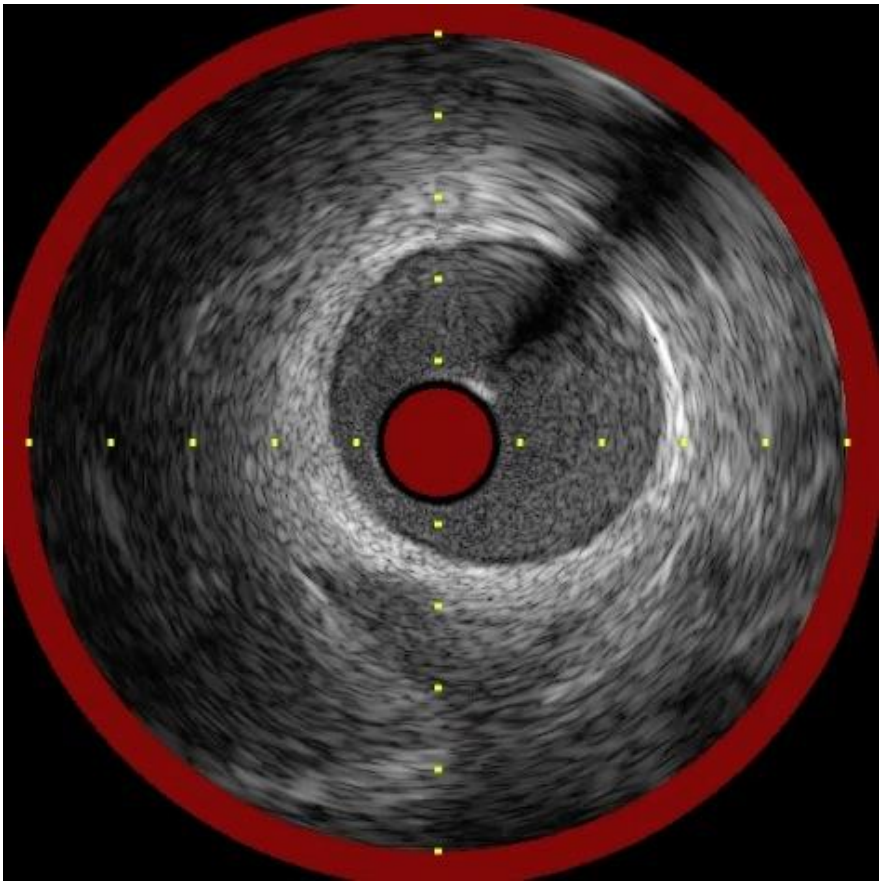



| ID | Location | Annotation |
|---|---|---|
| 1 | 7.38 | |
| 2 | 9.69 | |
| 3 | 14.29 | |
| 5 | 5.38 | Stent Start |
| 6 | 23.85 | Stent End |

For the same patient, longitudinal measurements are recorded as noted below. In addition, a cross-sectional view from both intravascular ultrasound and infrared spectroscopy is included below. The red ring around the ultrasound image represents real-time spectroscopy. In this case, no lipid or significant atherosclerosis is identified.

Longitudinal Measurements:

| ID | Start | End | Length | Notes |
|---|---|---|---|---|
| 158 | 9.69 | 7.38 | 2.31 | |
| 159 | 14.29 | 7.38 | 6.92 | |
| 160 | 14.29 | 9.69 | 4.61 | |
| 194 | 5.38 | 7.38 | 2.00 | |
| 195 | 5.38 | 9.69 | 4.31 | |
| 196 | 5.38 | 14.29 | 8.92 | |
| 197 | 23.85 | 7.38 | 16.48 | |
| 198 | 23.85 | 9.69 | 14.17 | |
| 199 | 23.85 | 14.29 | 9.56 | |
| 200 | 23.85 | 5.38 | 18.48 | |



A second run-in patient is illustrated below. The horizontal scan display in this case reveals multiple yellow coded areas in the scanned sector. These represent lipid pools detected by infrared spectroscopy. In addition, this patient exhibited significant coronary artery disease.

F-A - 020-008_1 - 001_1 - LCX

NIR Information:

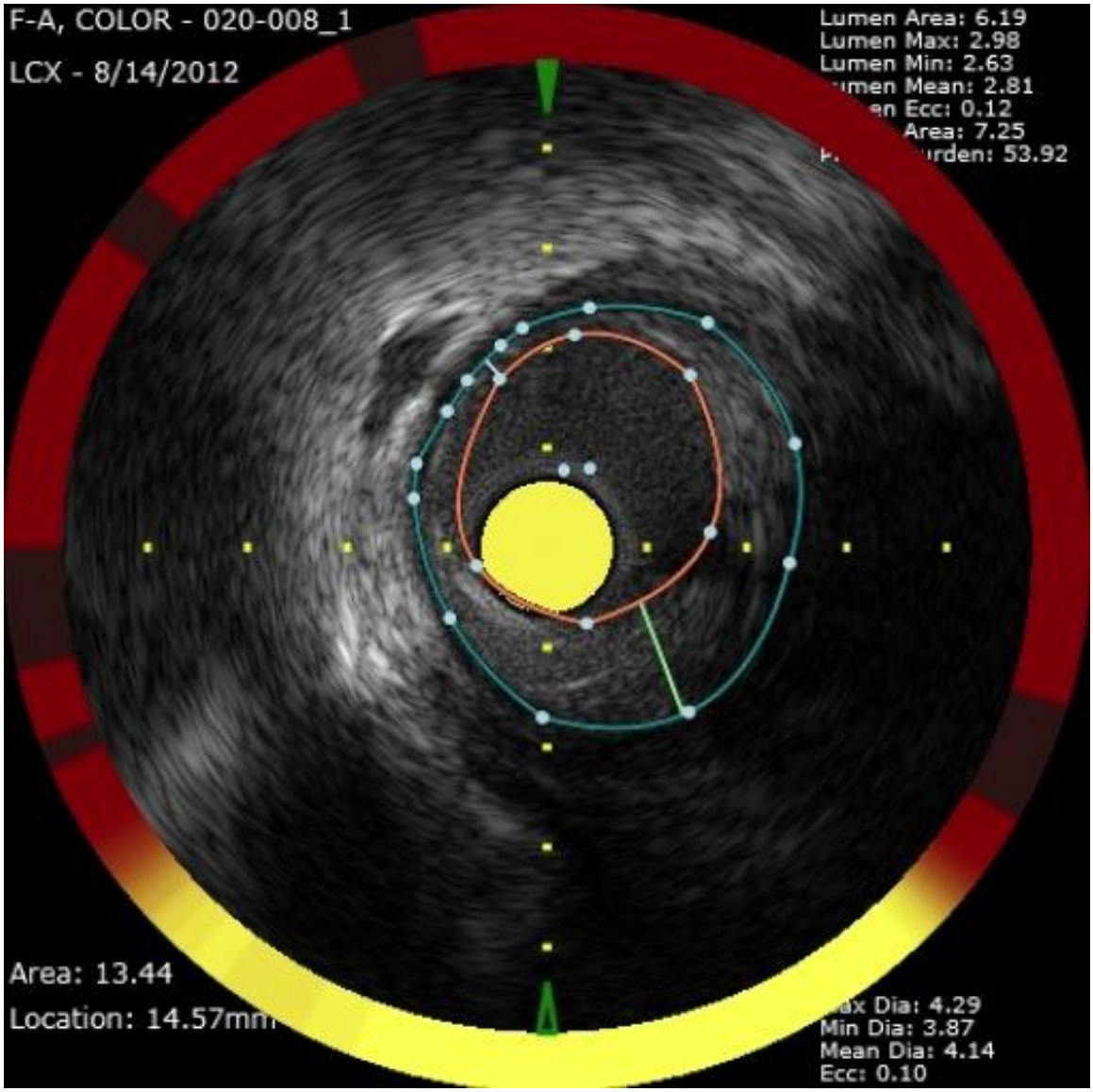

| ID | Location | Annotation |
|---|---|---|
| 5 | 12.87 | |
| 4 | 16.01 | |
| 3 | 10.05 | |
| 2 | 14.57 | |
| 1 | 22.37 | |

F-A - 020-008_1 - 001_1 - LCX

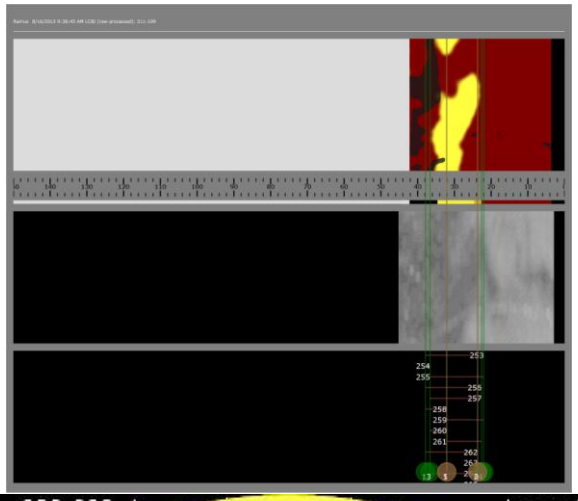
Longitudinal Measurements:

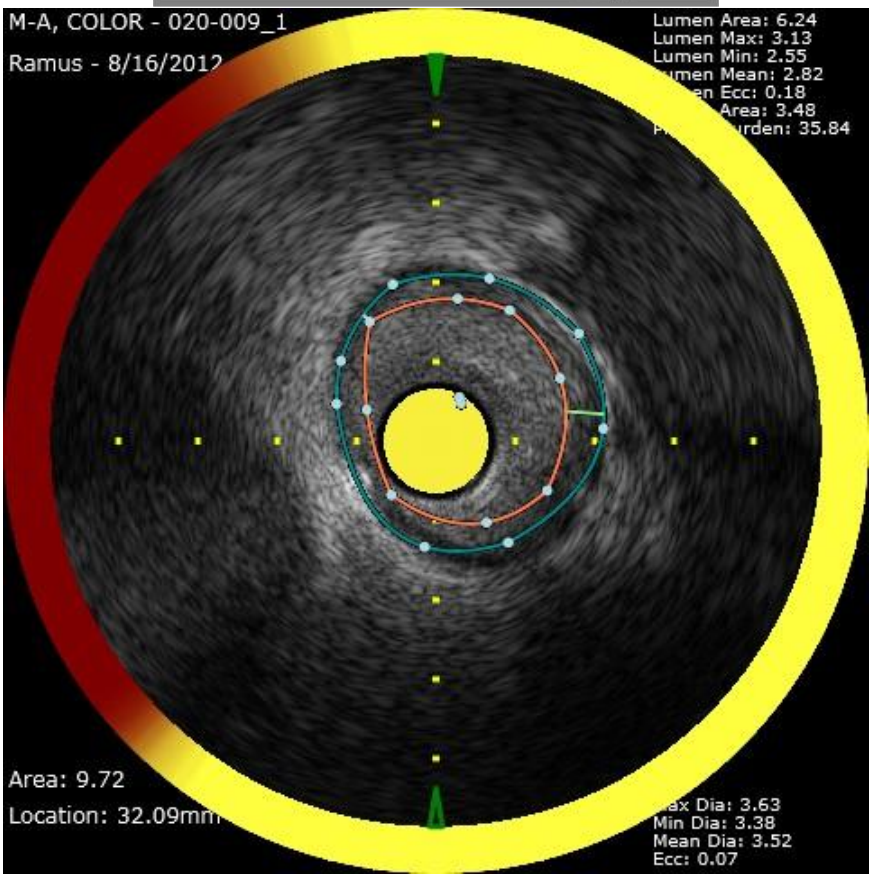
| ID | Start | End | Length | Notes |
|---|---|---|---|---|
| 170 | 14.57 | 22.37 | 7.80 | |
| 171 | 10.05 | 22.37 | 12.31 | |
| 172 | 10.05 | 14.57 | 4.51 | |
| 173 | 16.01 | 22.37 | 6.36 | |
| 174 | 16.01 | 14.57 | 1.44 | |
| 175 | 16.01 | 10.05 | 5.95 | |
| 176 | 12.87 | 22.37 | 9.50 | |
| 177 | 12.87 | 14.57 | 1.70 | |
| 178 | 12.87 | 10.05 | 2.81 | |
| 179 | 12.87 | 16.01 | 3.14 | |

The coronary artery disease is easily appreciated in this cross-sectional View taken from location 14.57. In this case, quantification of the intravascular ultrasound image reveals significant plaque burden oriented inferiorly. In addition, examination of the spectroscopic image reveals high lipid plaque burden in that area. This scan is taken from the proximal left circumflex coronary artery.



A third patient study is illustrated below. These data are obtained from a ramus branch of the left coronary artery. The horizontal scan illustrates a different morphology for lipid deposition than was present in the first two examples. There is a single circumferential large lipid deposit which is visualized easily. This is associated with a significant degree of atherosclerosis demonstrated on intravascular ultrasound imaging. Cross-sectional imaging at location 32.09 illustrates the almost circumferential distribution of lipid laden plaque.





As noted previously, Data was obtained for a total of 16 patients. There were no complications during these procedures.

Subjective technical evaluation of the catheter system was significant in terms of tractability and flexibility in vivo. Although data were obtained from all patients, limited interrogation of distal vessels was possible. We felt that this significantly limited the potential utility of the system and, with other operators, offered feedback to involved engineers. This has resulted in a new catheter design, pullback system, and improvements to the infrared and ultrasound console.

We have recently received new catheters and have upgraded our console. Physician and laboratory staff training is currently underway and we anticipate performing studies using the system in the near future.

**Key Research Accomplishments**

In the first quarter following for approval of this protocol, and initial cohort of patients has been studied. We have demonstrated the utility of simultaneous intravascular ultrasound and near infrared spectroscopy for delineating atherosclerotic lesions and associated intramural lipid.

Data collection, as indicated in the protocol, has been accomplished in all studies. No complications have ensued in run-in patients.

Technical improvements to the catheter system, pull back system, and electronics have been made.

**Reportable Outcomes**

None at this time.

**Conclusion**

Near infrared spectroscopy and simultaneous intravascular ultrasound images can be obtained safely in patients. Improvements in catheters and associated hardware should make interrogation of distal vessels possible.

Using these technologies make identification of vulnerable plaques possible the current study valuable as defined in the statement of work.

## References

None

## Appendices

None